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(54) Title: PRESSURE RELIEF VALVE FOR AN INHALATOR (57) Abstract A valve (10) includes a valve case secured to a container (12) that stores a pressurized fluid, and a valve pin moveable relative to the valve case (14) and defining a fluid path in cooperation with the valve case. A seal (30) separates the fluid path into an upstream portion communicating with inside of the container and a downstream portion communicating with outside of the container. The valve pin (16) has a main passage (38) always communicating with outside of the container, and a bypass passage (62). A valve pin adjuster (44), responsive to change in pressure acting on the valve pin within the container, shifts the valve pin between a first position where fluid communication between the main passage and the upstream portion of the fluid path is blocked to prevent the pressurized fluid from being discharged from the container, and a second position where fluid communication between the upstream and downstream portions of the fluid path is established through the bypass passage to allow the flow of the pressurized fluid from the container.			

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DESCRIPTION
PRESSURE RELIEF VALVE FOR AN INHALATOR

Technical Field

The present invention relates to a valve for
5 use in an inhalator for aerosolizing a fluid stored
in a container by using high pressure gas, for
example, liquefied carbon dioxide (CO₂) gas, as
propellants, and more particularly to an improved
valve adapted for restraining excessive increase in
10 pressure within the container.

Background Art

There is known apparatus adapted for
aerosolizing a fluid such as medicine, that is
stored in a container along with high pressure gas
15 as propellant, through a valve fixed to an inlet of
the container. The apparatus of this type has
conventionally utilized a specific fluorocarbon
(flon) as propellant. At present, the apparatus
tends to use hydrofluorocarbon HFC134a as an
20 alternative of the specific flon with increasing
concern about environmental protection. However,
HFC134a influences not ozonosphere but global
warming not less than one thousand times the degree
caused by CO₂. Thus, if HFC134a is used with great
25 frequency, it seems that serious environmental
problem occurs. Accordingly, use of CO₂ gas or
inert gases, for instance, nitrogen, helium, neon,
krypton, xenon and radon, acting as aerosol
propellant, is at present proposed.

30 In the case of using such gases as propellant,
it is required to liquefy or compress the gases for
reducing a size of container as well as the flon
conventionally used. The liquefied gases have a
high vapor pressure. For example, liquefied CO₂ gas

has vapor pressure of 60kgf/cm² at 20°C. It is also desirable that inert gases are liquefied or compressed under pressure of not less than 50kgf/cm² in order to increase volumetric efficiency thereof.

- 5 Japanese Patent Application First Publication No. 7-241498 discloses an aerosol using such liquefied gas.

The liquefied gas as propellant to be filled in the container has high vapor pressure as described
10 above. The vapor pressure within the container tends to rapidly increase in response to even slight temperature rise of the ambient atmosphere. Therefore, such the aerosol must be handled with considerable care.

- 15 The above-described conventional art discloses the aerosol including a gas cartridge, a sealing plate fixed to an opening of the gas cartridge, and a gas-emitting valve mounted to the opening of the gas cartridge. Upon using the aerosol, the sealing
20 plate is pierced by a needle connected with the valve to permit liquefied gas to be discharged from the gas cartridge through the sealing plate pierced. The sealing plate is adapted to be locally ruptured and escape the liquefied gas from the gas cartridge
25 in response to increase in vapor pressure therewithin during storage before use. The conventional art has effects of avoiding contingencies that may be caused due to the increasing vapor pressure within the gas cartridge,
30 whereby the gas cartridge can be safely stored. However, if the gas cartridge is used once and then vapor pressure therewithin excessively increases, the conventional art can no longer teach any effective measure.

- 35 It is an object of the present invention to

provide a valve for use in an inhalator that is capable of relieving pressure within a container of the inhalator in response to a large increase in vapor pressure therewithin.

- 5 It is a further object of the present invention to provide an inhalator for aerosolizing fluid stored in a container with pressurized gas, that is capable of always restraining excessive increase in vapor pressure within the container.

10 **Disclosure of Invention**

According to one aspect of the present invention, there is provided a valve for an inhalator including a container having a pressurized fluid, comprising:

- 15 a valve case secured to the container;
 a valve pin moveable relative to said valve case, said valve pin cooperating with said valve case to define a fluid path for discharging the pressurized fluid from the container, said valve pin
20 having a portion extending through said valve case into the container to be exposed to the pressurized fluid;

- a seal arranged within said valve case so as to separate said fluid path into an upstream portion
25 communicating with inside of the container and a downstream portion communicating with outside of the container; and

- said valve pin defining a main passage always communicating with outside of the container and a
30 bypass passage, said valve pin having a first position where fluid communication between said main passage and said upstream portion of said fluid path is blocked to prevent the pressurized fluid from being discharged from the container and a second
35 position where fluid communication between said

upstream portion and said downstream portion of said fluid path is established through said bypass passage to permit the pressurized fluid to flow from the container;

5 a valve pin adjuster shifting said valve pin between said first position and said second position in response to change in pressure acting on said valve pin, said valve pin adjuster being mounted to said valve pin.

10 According to a further aspect of the present invention, there is provided an inhalator, comprising:

 a container having an open end and a pressurized fluid;

15 a valve case secured to the open end of said container;

 a valve pin moveable relative to said valve case, said valve pin cooperating with said valve case to define a fluid path through which said
20 pressurized fluid is discharged from said container, said valve pin having a portion extending through said valve case into said container to be exposed to said pressurized fluid;

 a seal arranged within said valve case so as to
25 separate said fluid path into an upstream portion communicating with inside of said container and a downstream portion communicating with outside of said container; and

 said valve pin defining a main passage always
30 communicating with outside of said container and a bypass passage, said valve pin having a first position where fluid communication between said main passage and said upstream portion of said fluid path is blocked to prevent said pressurized fluid from
35 being discharged from said container and a second

position where fluid communication between said upstream portion and said downstream portion of said fluid path is established through said bypass passage to permit said pressurized fluid to flow
5 from said container;

a valve pin adjuster shifting said valve pin between said first position and said second position in response to change in pressure within said container, said valve pin adjuster being mounted to
10 said valve pin.

According to a still further aspect of the present invention, there is provided a valve for an inhalator including a container, comprising:

a pressurized fluid stored in the container;
15 a valve case secured to the container;

a valve pin moveable relative to said valve case, said valve pin cooperating with said valve case to define a fluid path through which said pressurized fluid is discharged from the container,
20 said valve pin having a portion extending through said valve case into the container to be exposed to said pressurized fluid;

a seal arranged within said valve case so as to separate said fluid path into an upstream portion
25 communicating with inside of the container and a downstream portion communicating with outside of the container; and

said valve pin defining a main passage always communicating with outside of the container and a
30 bypass passage, said valve pin having a first position where fluid communication between said main passage and said upstream portion of said fluid path is blocked to prevent said pressurized fluid from being discharged from the container and a second
35 position where fluid communication between said

upstream portion and said downstream portion of said fluid path is established through said bypass passage to permit said pressurized fluid to flow from the container;

5 a valve pin adjuster shifting said valve pin between said first position and said second position in response to change in pressure acting on said valve pin, said valve pin adjuster being mounted to said valve pin.

10 According to a further aspect of the present invention, there is provided an inhalator, comprising:

a container having an open end;

a pressurized fluid stored in said container;

15 a valve case secured to the open end of said container;

a valve pin moveable relative to said valve case, said valve pin cooperating with said valve case to define a fluid path through which said
20 pressurized fluid is discharged from said container;

a seal arranged within said valve case so as to separate said fluid path into an upstream portion communicating with inside of said container and a downstream portion communicating with outside of
25 said container; and

said valve pin defining a main passage always communicating with outside of said container and a bypass passage, said valve pin having a first position where fluid communication between said main
30 passage and said upstream portion of said fluid path is blocked to prevent said pressurized fluid from being discharged from said container and a second position where fluid communication between said upstream portion and said downstream portion of said
35 fluid path is established through said bypass

passage to permit said pressurized fluid to flow from said container;

a valve pin adjuster shifting said valve pin between said first position and said second position
5 in response to change in pressure within said container, said valve pin adjuster being mounted to said valve pin.

Brief Description of Drawings

Fig. 1 is a section of a valve of a first
10 embodiment according to the present invention;

Fig. 2 is a view similar to Fig. 1, but showing the valve placed in a position different from Fig. 1;

Fig. 3 is a view similar to Figs. 1 and 2, but
15 showing the valve placed in a position different from Figs. 1 and 2;

Fig. 4 is a section of a valve of a second embodiment according to the present invention;

Fig. 5 is a view of a valve pin of the valve
20 shown in Fig. 4, as viewed in a direction indicated by the arrow 5 of Fig. 4;

Fig. 6 is a section of a valve of a third embodiment according to the present invention;

Fig. 7 is a view of a valve pin of the valve
25 shown in Fig. 6, as viewed in a direction indicated by the arrow 7 of Fig. 6;

Fig. 8 is a section of a valve of a fourth embodiment according to the present invention; and

Fig. 9 is a section of a valve of a fifth
30 embodiment according to the present invention.

Best Mode for Carrying Out the Invention

Referring now to Figs. 1 to 3, a valve 10 and an inhalator with the valve 10, according to the present invention, are explained.

35 As illustrated in Fig. 1, the inhalator

includes a container 12 having an open end 12A that defines an aperture 12B. The container 12 receives a fluid such as medicine, and pressurized gas acting as propellant, for instance, liquefied carbon dioxide (CO₂) gas or the like. The valve 10 is hermetically mounted to the open end 12A of the container 12. The valve 10 includes a valve case 14 secured to the open end 12A of the container 12 and a valve pin 16 axially moveable relative to the valve case 14. The valve case 14 has a central through bore 32 through which the valve pin 16 moves between first, second and third positions described in detail later. The valve case 14 and the valve pin 16 cooperate to define therebetween a fluid path for discharging the fluid entrained on the pressurized gas (the mixture is hereinafter referred to as merely "pressurized fluid") from the container 12. The fluid path allows fluid communication between inside and outside of the container 12. The pressurized fluid is discharged from inside of the container 12 through the fluid path. The valve pin 16 extends through the valve case 14 and has one axial end, a lower end as viewed in Fig. 1, projecting inside the case 14 and an opposite axial end, an upper end as viewed in Fig. 1, projecting outside the valve case 14. A nozzle button 18 acting as a nozzle and a pushbutton is mounted to the upper end of the valve pin 16. The nozzle button 18 has a passage feeding the pressurized fluid from the container 12 through the valve pin 16 as explained later, and an aerosolizing outlet communicating with the passage to aerosolize the pressurized fluid therefrom.

Specifically, the valve case 14 is fitted into the aperture 12B and caulked at the open end 12A.

The fluid path is disposed between an inner peripheral surface of the valve case 14 that defines the through bore 32 and an outer circumferential surface of the valve pin 16 that is opposed to the inner peripheral surface of the valve case 14. The valve case 14 includes a case body 20 formed with a stepped bore 22 partly forming the through bore 32 and a plug 24 disposed within the stepped bore 22. The stepped bore 22 includes a larger-diameter portion 26 exposed to the inside of the container 12, and a smaller-diameter portion 28 connected with the larger-diameter portion 26. The plug 24 is fitly fixed to the larger-diameter portion 26 of the stepped bore 22 and formed with an opening forming a part of the through bore 32. The smaller-diameter portion 28 of the stepped bore 22 cooperates with the plug 24 to define an annular groove for retaining a seal 30 of a ring shape.

The seal 30 is fitted to the annular groove and partly projects into the through bore 32 to come into contact with the outer circumferential surface of the valve pin 16. The seal 30 separates the fluid path into an upstream portion communicating with inside of the container 12 and a downstream portion communicating with outside of the container 12. The seal 30 blocks the fluid path to prevent the pressurized fluid from being discharged from inside of the container 12 to outside thereof. The seal 30 is made of a suitable elastic material.

As illustrated in Fig. 1, the valve pin 16 includes a greater-diameter pin portion 34 partly projecting to the outside of the container 12 and a smaller-diameter pin portion 36 partly projecting into the container 12. The smaller-diameter pin portion 36 has a predetermined length and is exposed

to the pressurized fluid.

The valve pin 16 defines a main passage 38 for feeding the pressurized fluid to outside of the container 12. The main passage 38 is formed in the greater-diameter pin portion 34 and always communicates with outside of the container 12 via the passage of the nozzle button 18. The main passage 38 includes an axially extending hole 40 and a radially outwardly extending orifice 42 connected with a bottom of the axially extending hole 40. The main passage 38 has an outlet open to the upper end face of the valve pin 16 and an inlet 43 open to the outer circumferential surface of the valve pin 16. Namely, the axially extending hole 40 is open to the upper end face of the valve pin 16 and the orifice 42 is open to the outer circumferential surface of the valve pin 16. The axially extending hole 40 has a relatively large diameter and the orifice 42 has a predetermined diameter smaller than the diameter of the hole 40. The orifice 42 determines an amount of flow of the pressurized fluid to be aerosolized per unit time. Accordingly, a diameter of the orifice 42 can be suitably determined depending on a required amount of the flow of the pressurized fluid to be aerosolized per unit time. The inlet 43 defined by the orifice 42 is arranged at a predetermined portion on the outer circumferential surface of the valve pin 16 which is spaced at a predetermined distance from the outlet in the axial direction of the valve pin 16. More specifically, the inlet 43 is located above the seal 30 and exposed to the downstream portion of the fluid path when the valve pin 16 is placed in the first position shown in Fig. 1, while the inlet 43 is located below the seal 30 and exposed to the

upstream portion of the fluid path when the valve pin 16 is placed in the third position shown in Fig. 2.

The valve pin has a bypass passage 62 formed on
5 the outer circumferential surface of the greater-diameter pin portion 34 of the valve pin 16. The bypass passage 62 is in the form of an annular groove having a V-shaped section shown in Fig. 1. The bypass passage 62 has a width farther extending
10 in the axial direction of the valve pin 16 than that of the seal 30. The bypass passage 62 is arranged in a predetermined portion which is exposed to the upstream portion of the fluid path when the valve pin 16 is in the first position shown in Fig. 1 and
15 which is substantially opposed to the seal 30 when the valve pin 16 is in the second position shown in Fig. 3. Thus, when the valve pin 16 is in the second position, the bypass passage 62 allows fluid communication between the upstream and downstream
20 portions of the fluid path.

The valve pin 16 has the first position shown in Fig. 1, in which fluid communication between the main passage 38 and the upstream portion of the fluid path is blocked to prevent the pressurized
25 fluid from being discharged from the container 12. In the first position, fluid communication between the bypass passage 62 and the downstream portion of the fluid path is also blocked. The fluid communication between the inside and outside of the
30 container 12 is restrained, so that the pressurized fluid is prohibited from being discharged from the container 12 via both of the main passage 38 and the bypass passage 62.

Further, the valve pin 16 has the second
35 position shown in Fig. 3, in which the fluid

communication between the upstream and downstream portions of the fluid path is established through the bypass passage 62 to permit the pressurized fluid to be discharged from the container 12. On the other hand, in the second position, the inlet 43 of the main passage 38 is exposed to outside of the valve case 14 whereby the fluid communication between the main passage 38 and the fluid path is interrupted. The fluid communication between the inside and outside of the container 12 via the bypass passage 62 is allowed but the fluid communication therebetween via the main passage 38 is prevented. Therefore, the pressurized fluid within the container 12 is permitted to flow to outside of the container 12.

The valve pin 16 also has a third position shown in Fig. 2. The valve pin 16 is moved to the third position by depressing the nozzle button 18 toward the container 12. In the third position, the fluid communication between the main passage 38 and the upstream portion of the fluid path is established. The fluid communication between the inside and outside of the container 12 is allowed via the main passage 38 to permit the pressurized fluid to be discharged from the container 12. In this position, the bypass passage 62 is located fully inside the container 12 to be inactive in fluid communication between inside and outside of the container 12.

The valve pin 16 is shifted by a valve pin adjuster 44 between the first and second positions in response to change in vapor pressure within the container 12 that acts on the valve pin 16. The valve pin adjuster 44 is slidably mounted to the smaller-diameter pin portion 36 of the valve pin 16.

The valve pin adjuster 44 holds the valve pin 16 in the first position when the vapor pressure within the container 12 is less than a predetermined value and in the second position when the vapor pressure
5 therewithin is not less than the predetermined value.

The valve pin adjuster 44 includes a stop 46 mounted to the valve pin 16 and a resilient member 52 acting between the valve case 14 and the lower
10 end of the valve pin 16. The stop 46 is fitted onto the smaller-diameter pin portion 36 of the valve pin 16 and slidable thereon in the axial direction. The resilient member 52 is in the form of a coiled spring in this embodiment. The valve pin adjuster
15 44 also includes a retainer 48 that supports one end of the resilient member 52 on an upper end face thereof. The retainer 48 is fixed to the lower end of the valve pin 16 by a fastening nut 50.

The stop 46 includes a flange 56 supporting an
20 opposite end of the resilient member 52 and a hollow cylindrical guide 58 that is connected with the flange 56 and guides the resilient member 52 along an outer circumferential surface thereof. The guide 58 and the resilient member 52 are disposed within
25 the container 12 and opposed to each other on their circumferential surfaces. The stop 46 defines a communicating passage 60 always fluidly connecting the upstream portion of the fluid path with inside of the container 12. The communicating passage 60
30 is formed on an upper surface of the flange 56.

The stop 46 is forced by a setting load of the resilient member 52 to be in contact with a shoulder portion 54 of the valve pin 16 that is disposed between the greater-diameter pin portion 34 and the
35 smaller-diameter pin portion 36. Specifically, as

shown in Fig. 1, an inner circumferential portion of the upper surface of the flange 56 of the stop 46 is in contact with the shoulder portion 54. The stop 46 is thus prevented from upwardly moving relative to the valve pin 16 by the contact of the flange 56 with the shoulder portion 54.

The stop 46 is forced by the vapor pressure within the container 12 to be in contact with a lower face of the valve case 14. Namely, an outer peripheral portion of the upper surface of the flange 56 of the stop 46 is in contact with an inner peripheral portion of a lower face of the plug 24 that surrounds the opening thereof. The setting load of the resilient member 52 is set at a predetermined value greater than the vapor pressure acting on the valve pin 16 under such a normal condition that the vapor pressure within the container 12 is within a constant pressure range. Accordingly, when the vapor pressure within the container 12 is within the constant pressure range, the flange 56 of the stop 46 is urged against the lower face of the valve case 14 while it is kept in contact with the shoulder 54 of the valve pin 16. In such a case, the valve pin 16 is held in the first position as shown in Fig. 1.

The retainer 48 has a stop-limiting portion on the upper end face that is in contact with the stop 46 to limit the downward movement of the stop 46 relative to the valve pin 16 when the valve pin 16 is placed in the second position shown in Fig. 3. Specifically, when the vapor pressure within the container 12 becomes not less than the predetermined value, the resilient member 52 is brought into a compressed state by the vapor pressure acting on the lower end of the valve pin 16 and a lower end face

of the retainer 48. The valve pin 16 with the retainer 48 is moved upwardly against the biasing force of the resilient member 52 until the upper end face of the retainer 48 comes into contact with a lower end of the cylindrical guide 58 of the stop 46. The upward movement of the valve pin 16 is thus restrained in the second position. During the upward movement of the valve pin 16, the upper surface of the flange 56 of the stop 46 is kept in contact with the lower face of the valve case 14.

An operation of the valve 10 of the above-described first embodiment is explained hereinafter.

When the nozzle button 18 is in a non-depressed position shown in Fig. 1, under condition that the vapor pressure within the container 12 is within the predetermined range, the valve pin 16 is held by the valve pin adjuster 44 in a normal position, i.e., the first position shown in Fig. 1. In this case, the inlet 43 of the main passage 38, i.e., the opening of the orifice 42, is located downstream of the seal 30 contacted with the outer circumferential surface of the valve pin 16. The main passage 38 is prevented from fluidly communicating with the upstream portion of the fluid path and then inside of the container 12. On the other hand, the bypass passage 62 is located upstream of the seal 30 and inactive in fluid communication with the upstream and downstream portions of the fluid path. As a result, the pressurized fluid within the container 12 is prevented from flowing therefrom through the main passage 38 and the bypass passage 62.

When the nozzle button 18 is depressed, the valve pin 16 is displaced into the third position shown in Fig. 2. At this time, the inlet 43 of the main passage 38 is located upstream of the seal 30

contacted with the outer circumferential surface of the valve pin 16. The main passage 38 is in fluid communication with the upstream portion of the fluid path and the inside of the container 12. Thus, the
5 pressurized fluid within the container 12 is discharged from the container 12 through the main passage 38 and the aerosolizing outlet of the nozzle button 18.

When the vapor pressure within the container 12
10 becomes not less than the predetermined value due to increase in atmospheric temperature under condition that the nozzle button 18 is in the non-depressed position, the pressure force acting on the valve pin 16 becomes greater than the biasing force of the
15 resilient member 52 to thereby deform the resilient member 52 to the compressed state. When the resilient member 52 is compressedly deformed by a predetermined degree, the retainer 48 comes into contact with the cylindrical guide 58 of the stop 46
20 and the valve pin 16 is placed in the second position shown in Fig. 3. In this condition, the bypass passage 62 of the valve pin 16 is opposed to the seal 30 and active to establish fluid communication between the upstream and downstream
25 portions of the fluid path. The inside of the container 12 is in fluid communication with the outside thereof via the bypass passage 62, whereby the vapor pressure exceeding the predetermined value is relieved from the container 12. Thus, the vapor
30 pressure within the container 12 is reduced.

When the vapor pressure within the container 12 decreases to a value less than the predetermined value, the valve pin 16 is moved back to the first position shown in Fig. 1, by the restoring force of
35 the resilient member 52. The fluid communication

between the upstream and downstream portions of the fluid path is blocked again by the hermetic contact of the seal 30 with the outer circumferential surface of the valve pin 16. The relief of the vapor pressure within the container 12 is thus prohibited.

As explained above, the valve 10 and the inhalator with the valve 10, according to the present invention, have a simple structure and assures avoiding contingencies that may be caused due to the excessive increase in vapor pressure within the container 12. Namely, the valve pin adjuster 44 allows the fluid communication between the inside and outside of the container 12 through the bypass passage 62 of the valve pin 16 in response to increase in vapor pressure within the container 12 to the predetermined value.

Further, if the vapor pressure within the container 12 is relieved therefrom once, the valve pin 16 can be returned to the normal first position by the restoring force of the resilient member 52. Accordingly, even if the vapor pressure within the container 12 increases to not less than the predetermined value again after the return of the valve pin 16 to the normal first position, the valve pin 16 can be displaced into the second position in response to the increase in vapor pressure within the container 12. Therefore, the vapor pressure can be relieved from the container 12 via the bypass passage 62 so that the vapor pressure within the container 12 can decrease to below the predetermined value. Thus, the innalator can always restrain excessive increase in vapor pressure within the container 12.

Furthermore, with the arrangement of the

communicating passage 60 on the flange 56 of the stop 46, the inside of the container 12 always communicates with the upstream portion of the fluid path. The fluid communication between them is
5 advantageous in securing a relief passage for relieving vapor pressure within the container 12 without being interrupted by the resilient member 52 upon the vapor pressure within the container 12 increasing.

10 Referring to Figs. 4 to 9, valves 100, 200, 300 and 400 of second, third, fourth and fifth embodiments according to the present invention are explained hereinafter, which differ in arrangement of the bypass passage of the valve pin from the
15 valve 10 of the above-described first embodiment. Like reference numerals denote like parts and therefore detailed explanations therefor are omitted.

Figs. 4 and 5 show the valve 100 of the second
20 embodiment, in which the bypass passage 162 is in the form of a round cutout formed on a predetermined portion on the outer circumferential surface of the valve pin 16. The bypass passage 162 has an arcuate section taken along the axial direction of the valve
25 pin 16 as shown in Fig. 4. The bypass passage 162 is partly defined by opposed peripheral edges shown in Fig. 5, that lie in parallel planes perpendicular to the axial direction of the valve pin 16.

Figs. 6 and 7 show the valve 200 of the third
30 embodiment. As illustrated in Fig. 6, the bypass passage 262 is in the form of substantially a half-round key way-shaped cutout, which is formed on a predetermined portion on the outer circumferential surface of the valve pin 16. The bypass passage 262
35 has a rectangular shape in a front view as shown in

Fig. 7. The bypass passage 262 is defined by opposed peripheral edges lying in parallel planes perpendicular to the axial direction of the valve pin 16.

5 In both of the second and third embodiments, the cutouts as the bypass passages 162 and 262 are arranged on the predetermined portions on the outer circumferential surface of the valve pin 16, respectively. With this arrangement, the formation
10 of the bypass passages 162 and 262 can be facilitated as compared with the bypass passage 62 of the first embodiment that is formed of the annular groove and therefore the manufacturing cost can be reduced.

15 Fig. 8 shows the valve 300 of the fourth embodiment, in which the bypass passage 362 is in the form of a through hole having a generally V shape as indicated by a phantom line. The bypass passage 362 has openings on the outer
20 circumferential surface of the valve pin 16 that are spaced from each other in the axial direction of the valve pin 16.

Fig. 9 shows the valve 400 of the fifth embodiment, in which the bypass passage 462 is in
25 the form of a straight and inclined through hole as indicated by a phantom line. The bypass passage 462 extends inclining relative to the axial direction of the valve pin 16 and has openings on the outer circumferential surface of the valve pin 16 that are
30 spaced from each other in the axial direction of the valve pin 16.

In the fourth and fifth embodiments, the openings of the bypass passages 362 and 462 that are open to the outer circumferential surface of the
35 valve pin 16 have smaller areas than the opening of

the bypass passage 62 formed into the annular groove in the first embodiment. Therefore, upon displacement of the valve pin 16, butting of the seal 30 against the periphery of the openings of the bypass passages 362 and 462 can be alleviated. As a result, the seal 30 can be prevented from being heavily deteriorated by duration of use, so that the durability of the seal 30 can be improved.

Industrial Applicability

As described above, the valve of the present invention is useful in relieving vapor pressure from a container storing pressurized fluid, in response to the vapor pressure within the container becoming not less than the predetermined value. The valve is applicable to apparatus, such as inhalator, sprayer and the like, including a container storing fluid along with pressurized gas as propellant. Further, the inhalator of the present invention is useful in always avoiding excessive increase in vapor pressure within a container that stores fluid along with pressurized gas. The inhalator of the present invention is generally applicable to inhalators using pressurized gas as aerosol propellant.

CLAIMS

1. A valve for an inhalator including a container having a pressurized fluid, comprising:

a valve case secured to the container;

5 a valve pin moveable relative to said valve case, said valve pin cooperating with said valve case to define a fluid path for discharging the pressurized fluid from the container, said valve pin having a portion extending through said valve case
10 into the container to be exposed to the pressurized fluid;

a seal arranged within said valve case so as to separate said fluid path into an upstream portion communicating with inside of the container and a
15 downstream portion communicating with outside of the container; and

said valve pin defining a main passage always communicating with outside of the container and a bypass passage, said valve pin having a first
20 position where fluid communication between said main passage and said upstream portion of said fluid path is blocked to prevent the pressurized fluid from being discharged from the container and a second position where fluid communication between said
25 upstream portion and said downstream portion of said fluid path is established through said bypass passage to permit the pressurized fluid to flow from the container;

a valve pin adjuster shifting said valve pin
30 between said first position and said second position in response to change in pressure acting on said valve pin, said valve pin adjuster being mounted to said valve pin.

2. A valve as claimed in claim 1, wherein said valve
pin adjuster holds said valve pin in said first
position when the pressure acting on said valve pin
5 is less than a predetermined value and in said second
position when the pressure acting on said valve pin
is not less than said predetermined value.

3. A valve as claimed in claim 1, wherein said valve
10 pin adjuster includes a resilient member acting
between said valve case and one axial end of said
valve pin that is disposed inside the container.

4. A valve as claimed in claim 3, wherein said valve
15 pin adjuster includes a stop moveable relative to
said valve pin in the axial direction of said valve
pin, said stop being mounted to said portion of said
valve pin and biased by said resilient member toward
said valve case.

20 5. A valve as claimed in claim 4, wherein said stop
defines a communicating passage fluidly connecting
said upstream portion of said fluid path with inside
of the container.

25 6. A valve as claimed in claim 5, wherein said stop
has a flange that supports said resilient member and
is contacted with said valve case.

30 7. A valve as claimed in claim 6, wherein said
communicating passage is formed on the flange of said
stop.

8. A valve as claimed in claim 4, wherein said valve pin has a shoulder portion, said shoulder portion being in contact with said stop to limit one axial movement of said stop when said valve pin is held in said first position and loses the contact therewith when said valve pin is held in said second position.
9. A valve as claimed in claim 4, wherein said valve pin adjuster includes a retainer supporting said resilient member, said retainer being mounted to one axial end of said valve pin that projects from said valve case to inside of the container.
10. A valve as claimed in claim 9, wherein said retainer has a limiting portion contacted with said stop to limit an opposite axial movement of said stop when said valve pin is held in said second position.
11. A valve as claimed in claim 1, wherein said bypass passage is arranged at a predetermined portion of said valve pin which is exposed to said upstream portion of said fluid path when said valve pin is held in said first position and which is substantially opposed to said seal when said valve pin is held in said second position.
12. A valve as claimed in claim 1, wherein said bypass passage includes a groove open to an outer periphery of said valve pin.
13. A valve as claimed in claim 12, wherein said bypass passage includes a through hole having openings spaced from each other in the axial

direction of said valve pin.

14. A valve as claimed in claim 1, wherein said valve pin has a third position where the fluid
5 communication between said main passage and said upstream portion of said fluid path is established to permit the pressurized fluid to be discharged from the container.

10 15. A valve as claimed in claim 14, wherein said main passage has an inlet open to a predetermined portion on an outer periphery of said valve pin which is axially spaced at a predetermined distance from an axial end of said valve pin that is disposed outside
15 of the container.

16. An inhalator, comprising:

a container having an open end and a pressurized fluid;

20 a valve case secured to the open end of said container;

a valve pin moveable relative to said valve case, said valve pin cooperating with said valve case to define a fluid path through which said pressurized
25 fluid is discharged from said container, said valve pin having a portion extending through said valve case into said container to be exposed to said pressurized fluid;

a seal arranged within said valve case so as to
30 separate said fluid path into an upstream portion communicating with inside of said container and a downstream portion communicating with outside of said container; and

said valve pin defining a main passage always communicating with outside of said container and a bypass passage, said valve pin having a first position where fluid communication between said main passage and said upstream portion of said fluid path is blocked to prevent said pressurized fluid from being discharged from said container and a second position where fluid communication between said upstream portion and said downstream portion of said fluid path is established through said bypass passage to permit said pressurized fluid to flow from said container;

a valve pin adjuster shifting said valve pin between said first position and said second position in response to change in pressure within said container, said valve pin adjuster being mounted to said valve pin.

17. An inhalator as claimed in claim 16, wherein said valve pin adjuster holds said valve pin in said first position when the pressure within said container is less than a predetermined value and in said second position when the pressure within said container is not less than said predetermined value.

18. An inhalator as claimed in claim 16, wherein said valve pin adjuster includes a resilient member acting between said valve case and one axial end of said valve pin that is disposed within said container.

19. An inhalator as claimed in claim 18, wherein said valve pin adjuster includes a stop moveable

relative to said valve pin in the axial direction of said valve pin, said stop being mounted to said portion of said valve pin and biased by said resilient member toward said valve case.

5

20. An inhalator as claimed in claim 19, wherein said stop defines a communicating passage fluidly connecting said upstream portion of said fluid path with inside of said container.

10

21. An inhalator as claimed in claim 20, wherein said stop has a flange that supports said resilient member and is contacted with said valve case.

15

22. An inhalator as claimed in claim 20, wherein said communicating passage is formed on the flange of said stop.

20

23. An inhalator as claimed in claim 19, wherein said valve pin has a shoulder portion, said shoulder portion being in contact with said stop to limit one axial movement of said stop when said valve pin is held in said first position and loses the contact therewith when said valve pin is held in said second position.

25

24. An inhalator as claimed in claim 18, wherein said valve pin adjuster includes a retainer supporting said resilient member, said retainer being mounted to one axial end of said valve pin that projects from said valve case to inside of said container.

30

25. An inhalator as claimed in claim 24, wherein
said retainer has a limiting portion contacted with
said stop to limit an opposite axial movement of said
stop when said valve pin is held in said second
5 position.

26. An inhalator as claimed in claim 16, wherein
said bypass passage is arranged at a predetermined
portion of said valve pin which is exposed to said
10 upstream portion of said fluid path when said valve
pin is held in said first position and which is
substantially opposed to said seal when said valve
pin is held in said second position.

15 27. An inhalator as claimed in claim 16, wherein
said bypass passage includes a groove open to an
outer periphery of said valve pin.

28. An inhalator as claimed in claim 27, wherein
20 said bypass passage includes a through hole having
openings spaced from each other in the axial
direction of said valve pin.

29. An inhalator as claimed in claim 16, wherein
25 said valve pin has a third position where the fluid
communication between said main passage and said
upstream portion of said fluid path is established to
permit said pressurized fluid to be discharged from
said container.

30

30. An inhalator as claimed in claim 29, wherein
said main passage has an inlet open to a
predetermined portion on an outer periphery of said

valve pin which is axially spaced at a predetermined distance from an axial end of said valve pin that is disposed outside of said container.

- 5 31. A valve for an inhalator including a container, comprising:

a pressurized fluid stored in the container;

a valve case secured to the container;

- 10 a valve pin moveable relative to said valve case, said valve pin cooperating with said valve case to define a fluid path through which said pressurized fluid is discharged from the container, said valve pin having a portion extending through said valve case into the container to be exposed to said
15 pressurized fluid;

- a seal arranged within said valve case so as to separate said fluid path into an upstream portion communicating with inside of the container and a downstream portion communicating with outside of the
20 container; and

- said valve pin defining a main passage always communicating with outside of the container and a bypass passage, said valve pin having a first position where fluid communication between said main
25 passage and said upstream portion of said fluid path is blocked to prevent said pressurized fluid from being discharged from the container and a second position where fluid communication between said upstream portion and said downstream portion of said
30 fluid path is established through said bypass passage to permit said pressurized fluid to flow from the container;

a valve pin adjuster shifting said valve pin

between said first position and said second position in response to change in pressure acting on said valve pin, said valve pin adjuster being mounted to said valve pin.

5

32. A valve as claimed in claim 31, wherein said valve pin adjuster holds said valve pin in said first position when the pressure acting on said valve pin is less than a predetermined value and in said second
10 position when the pressure acting on said valve pin is not less than said predetermined value.

33. A valve as claimed in claim 31, wherein said valve pin adjuster includes a resilient member acting
15 between said valve case and one axial end of said valve pin that is disposed inside the container.

34. A valve as claimed in claim 33, wherein said valve pin adjuster includes a stop moveable relative
20 to said valve pin in the axial direction of said valve pin, said stop being mounted to said portion of said valve pin and biased by said resilient member toward said valve case.

25 35. A valve as claimed in claim 34, wherein said stop defines a communicating passage fluidly connecting said upstream portion of said fluid path with inside of the container.

30 36. A valve as claimed in claim 35, wherein said stop has a flange that supports said resilient member and is contacted with said valve case.

37. A valve as claimed in claim 36, wherein said communicating passage is formed on the flange of said stop.

5 38. A valve as claimed in claim 34, wherein said valve pin has a shoulder portion, said shoulder portion being in contact with said stop to limit one axial movement of said stop when said valve pin is held in said first position and loses the contact
10 therewith when said valve pin is held in said second position.

39. A valve as claimed in claim 34, wherein said valve pin adjuster includes a retainer supporting
15 said resilient member, said retainer being mounted to one axial end of said valve pin that projects from said valve case to inside of the container.

40. A valve as claimed in claim 39, wherein said
20 retainer has a limiting portion contacted with said stop to limit an opposite axial movement of said stop when said valve pin is held in said second position.

41. A valve as claimed in claim 31, wherein said
25 bypass passage is arranged at a predetermined portion of said valve pin where is exposed to said upstream portion of said fluid path when said valve pin is held in said first position and which is substantially opposed to said seal when said valve
30 pin is held in said second position.

42. A valve as claimed in claim 31, wherein said bypass passage includes a groove open to an outer

periphery of said valve pin.

43. A valve as claimed in claim 42, wherein said
bypass passage includes a through hole having
5 openings spaced from each other in the axial
direction of said valve pin.

44. A valve as claimed in claim 31, wherein said
valve pin has a third position where the fluid
10 communication between said main passage and said
upstream portion of said fluid path is established to
permit said pressurized fluid to be discharged from
the container.

15 45. A valve as claimed in claim 44, wherein said
main passage has an inlet open to a predetermined
portion on an outer periphery of said valve pin which
is axially spaced at a predetermined distance from an
axial end of said valve pin that is disposed outside
20 of the container.

46. A valve as claimed in claim 31, wherein said
pressurized fluid includes a fluid to be aerosolized
and a propellant.

25

47. A valve as claimed in claim 46, wherein said
propellant includes a liquefied or compressed carbon
dioxide gas.

30 48. An inhalator, comprising:
a container having an open end;
a pressurized fluid stored in said container;
a valve case secured to the open end of said

container;

a valve pin moveable relative to said valve case, said valve pin cooperating with said valve case to define a fluid path through which said pressurized fluid is discharged from said container;

a seal arranged within said valve case so as to separate said fluid path into an upstream portion communicating with inside of said container and a downstream portion communicating with outside of said container; and

said valve pin defining a main passage always communicating with outside of said container and a bypass passage, said valve pin having a first position where fluid communication between said main passage and said upstream portion of said fluid path is blocked to prevent said pressurized fluid from being discharged from said container and a second position where fluid communication between said upstream portion and said downstream portion of said fluid path is established through said bypass passage to permit said pressurized fluid to flow from said container;

a valve pin adjuster shifting said valve pin between said first position and said second position in response to change in pressure within said container, said valve pin adjuster being mounted to said valve pin.

49. An inhalator as claimed in claim 48, wherein said valve pin adjuster holds said valve pin in said first position when the pressure within said container is less than a predetermined value and in said second position when the pressure within said

container is not less than said predetermined value.

50. An inhalator as claimed in claim 48, wherein
said valve pin adjuster includes a resilient member
5 acting between said valve case and one axial end of
said valve pin that is disposed within said
container.

51. An inhalator as claimed in claim 50, wherein
10 said valve pin adjuster includes a stop moveable
relative to said valve pin in the axial direction of
said valve pin, said stop being mounted to said
portion of said valve pin and biased by said
resilient member toward said valve case.

15 52. An inhalator as claimed in claim 51, wherein
said stop defines a communicating passage fluidly
connecting said upstream portion of said fluid path
with inside of said container.

20 53. An inhalator as claimed in claim 52, wherein
said stop has a flange that supports said resilient
member and is contacted with said valve case.

25 54. An inhalator as claimed in claim 53, wherein
said communicating passage is formed on the flange of
said stop.

30 55. An inhalator as claimed in claim 51, wherein
said valve pin has a shoulder portion, said shoulder
portion being in contact with said stop to limit one
axial movement of said stop when said valve pin is
held in said first position and loses the contact

therewith when said valve pin is held in said second position.

56. An inhalator as claimed in claim 51, wherein
5 said valve pin adjuster includes a retainer supporting said resilient member, said retainer being mounted to one axial end of said valve pin that projects from said valve case to inside of said container.

10 57. An inhalator as claimed in claim 56, wherein said retainer has a limiting portion contacted with said stop to limit an opposite axial movement of said stop when said valve pin is held in said second
15 position.

58. An inhalator as claimed in claim 48, wherein said bypass passage is arranged at a predetermined portion of said valve pin which is exposed to said
20 upstream portion of said fluid path when said valve pin is held in said first position and which is substantially opposed to said seal when said valve pin is held in said second position.

25 59. An inhalator as claimed in claim 48, wherein said bypass passage includes a groove open to an outer periphery of said valve pin.

60. An inhalator as claimed in claim 59, wherein
30 said bypass passage includes a through hole having openings spaced from each other in the axial direction of said valve pin.

61. An inhalator as claimed in claim 48, wherein said valve pin has a third position where the fluid communication between said main passage and said upstream portion of said fluid path is established to permit said pressurized fluid to be discharged from said container.

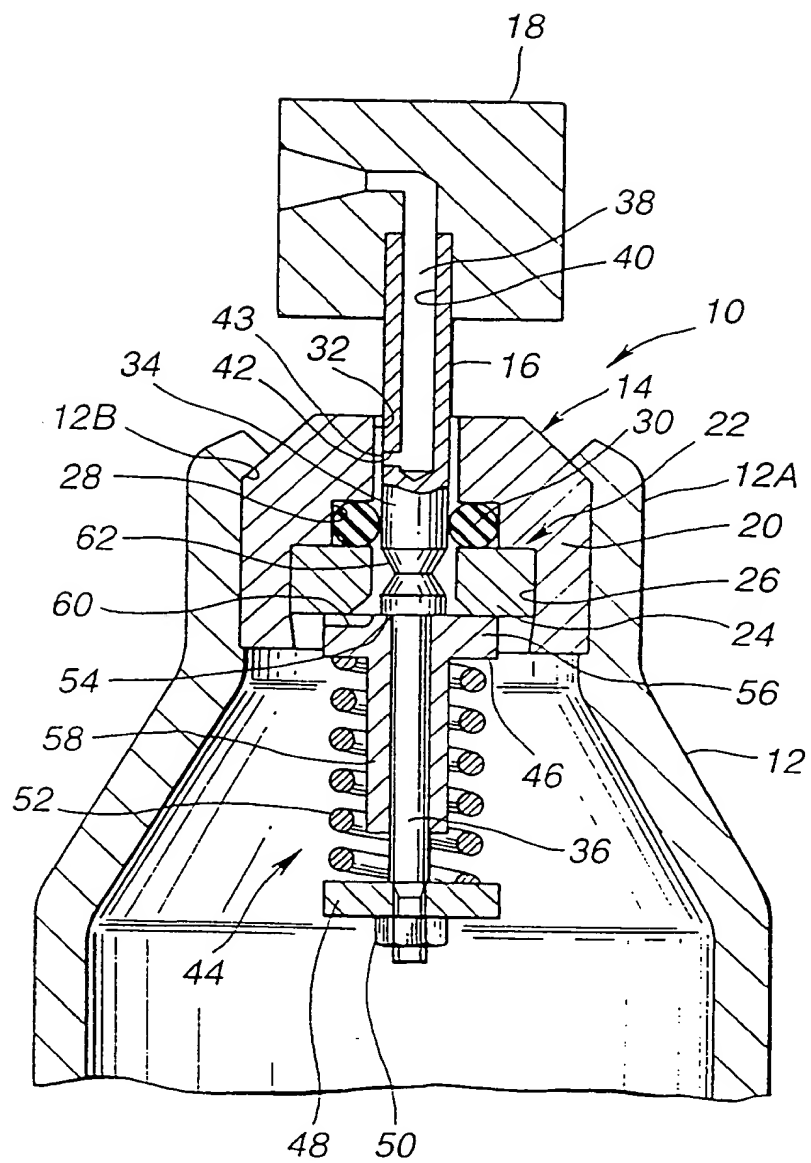
62. An inhalator as claimed in claim 61, wherein said main passage has an inlet open to a predetermined portion on an outer periphery of said valve pin which is axially spaced at a predetermined distance from an axial end of said valve pin that is disposed outside of said container.

63. A valve as claimed in claim 48, wherein said pressurized fluid includes a fluid to be aerosolized and a propellant.

64. A valve as claimed in claim 63, wherein said propellant includes a liquefied or compressed carbon dioxide gas.

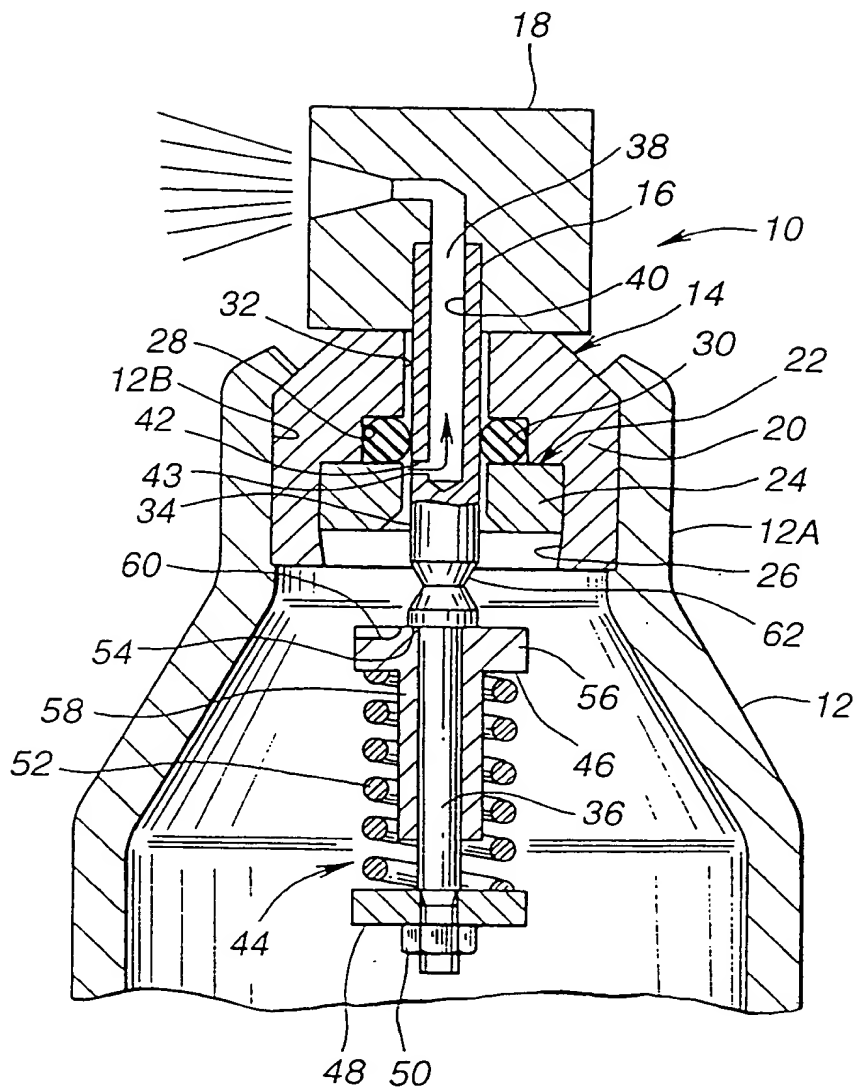
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FIG.1



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FIG.2



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FIG.3

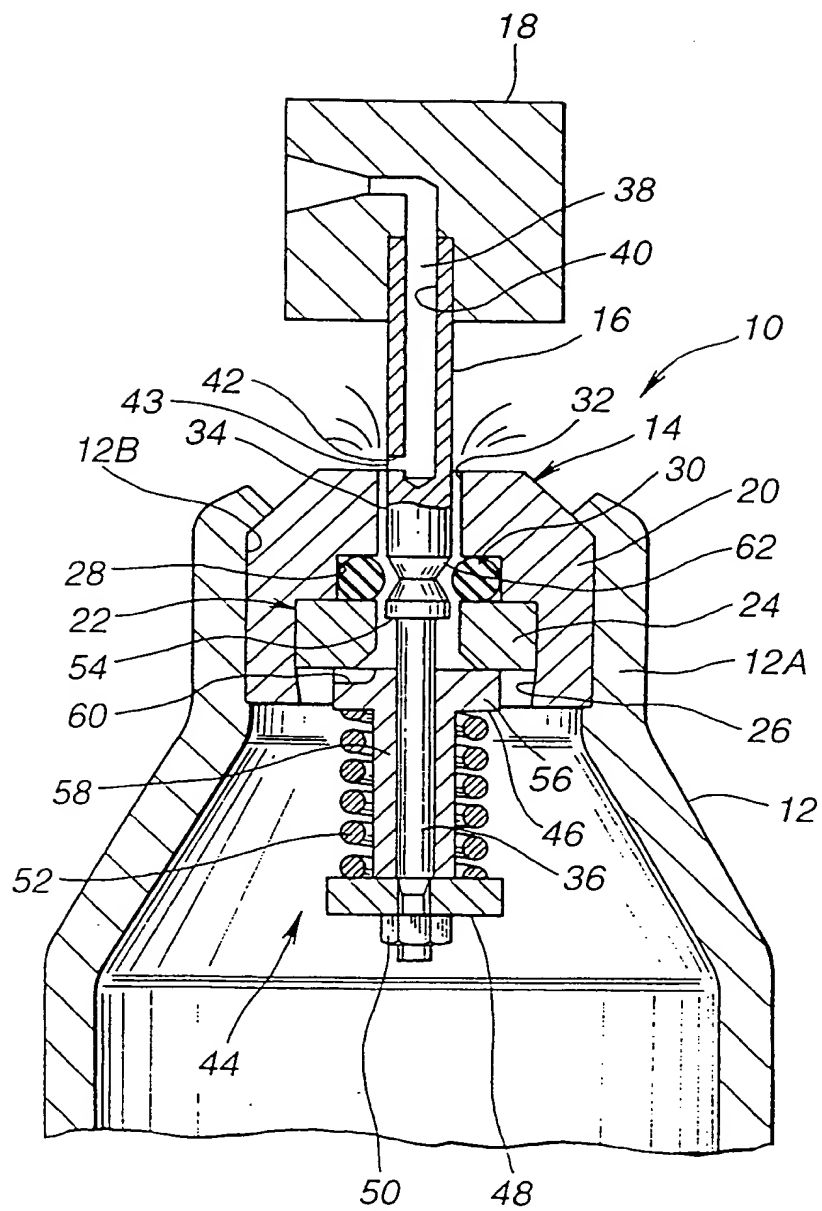


FIG.4

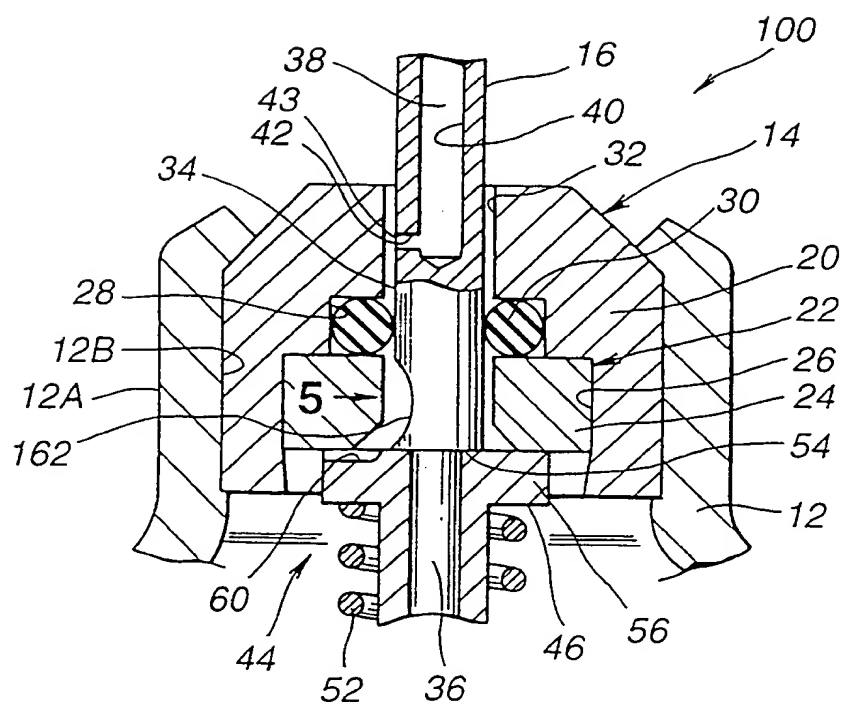


FIG.5

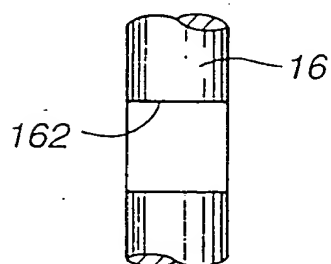


FIG.6

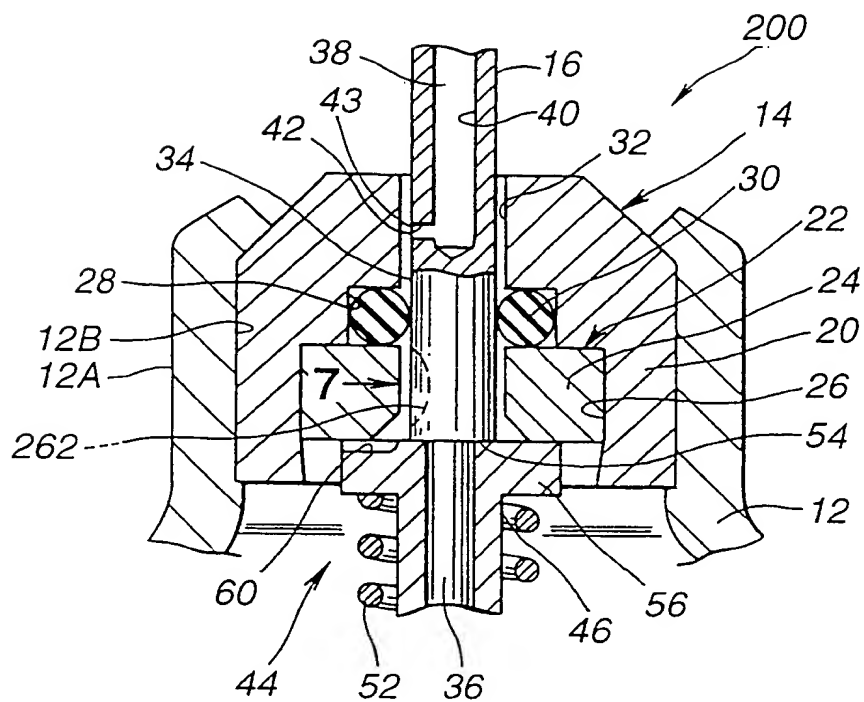


FIG.7

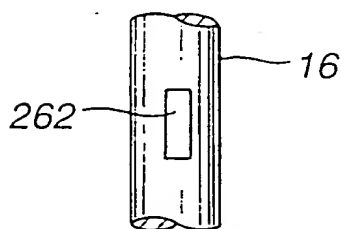


FIG.8

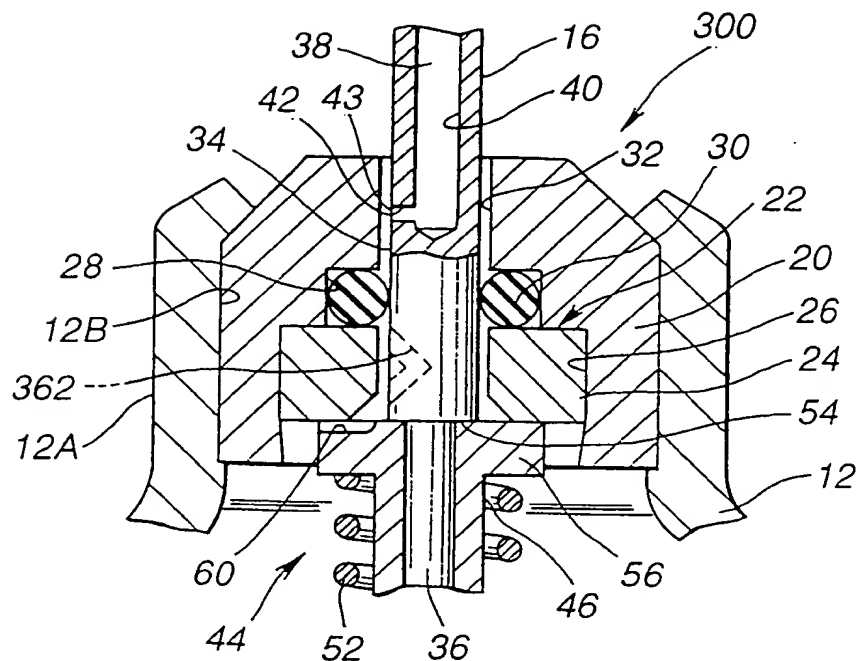
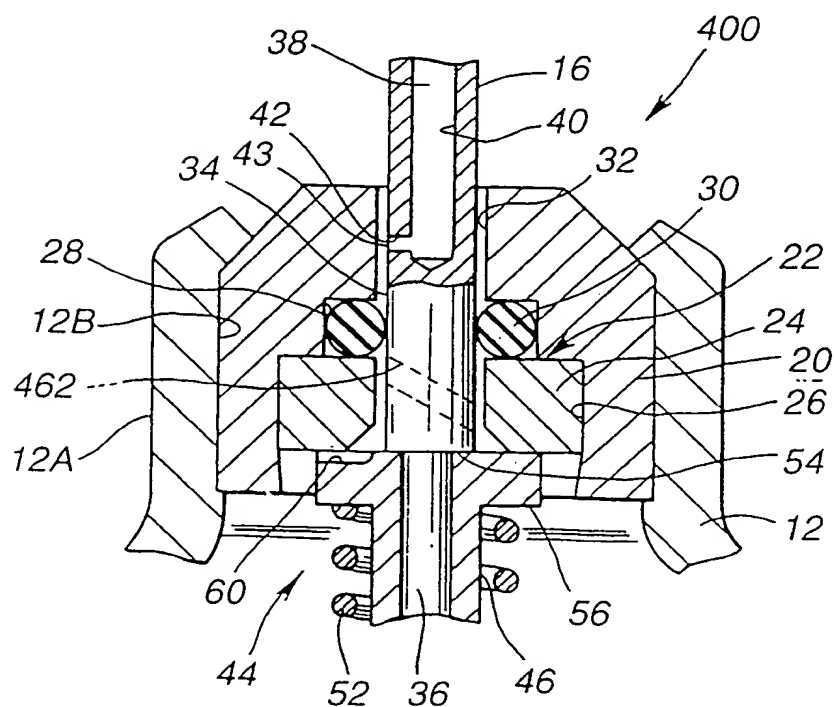


FIG.9



INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 99/01387

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B65D83/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 3 866 804 A (STEVENS SILVESTER WILLIAM) 18 February 1975 (1975-02-18)</p> <p>the whole document --- -/--</p>	<p>1-7, 11, 12, 14-22, 26, 27, 29-37, 41, 42, 44-46, 48-54, 58, 59, 61-64</p>

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search 14 July 1999	Date of mailing of the international search report 20/07/1999
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040. Tx. 31 651 epo nl. Fax: (+31-70) 340-3016	Authorized officer SERRANO GALARRAGA, J

INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 99/01387

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 666 148 A (WEBSTER MILO E) 30 May 1972 (1972-05-30) the whole document ---	1-4, 14-19, 29-34, 44-46, 48-51, 61-64
A	US 3 519 172 A (BRUCE JOHN K) 7 July 1970 (1970-07-07) the whole document ---	1-4, 14-19, 29-34, 44-46, 48-51, 61-64
A	US 3 005 577 A (WEBSTER) 24 October 1961 (1961-10-24) the whole document ---	1-4, 14-19, 29-34, 44-46, 48-51, 61-64
A	US 3 870 203 A (FRANKENBERG HENRY E) 11 March 1975 (1975-03-11) the whole document ---	1-4, 14-19, 29-34, 44-46, 48-51, 61-64
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A	US 5 645 192 A (AMIDZICH BRADFORD G) 8 July 1997 (1997-07-08) abstract: figures ---	1-4, 14-19, 29-34, 44-46, 48-51, 61-64
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INTEL PATENT SEARCH REPORT

Information on patent family members

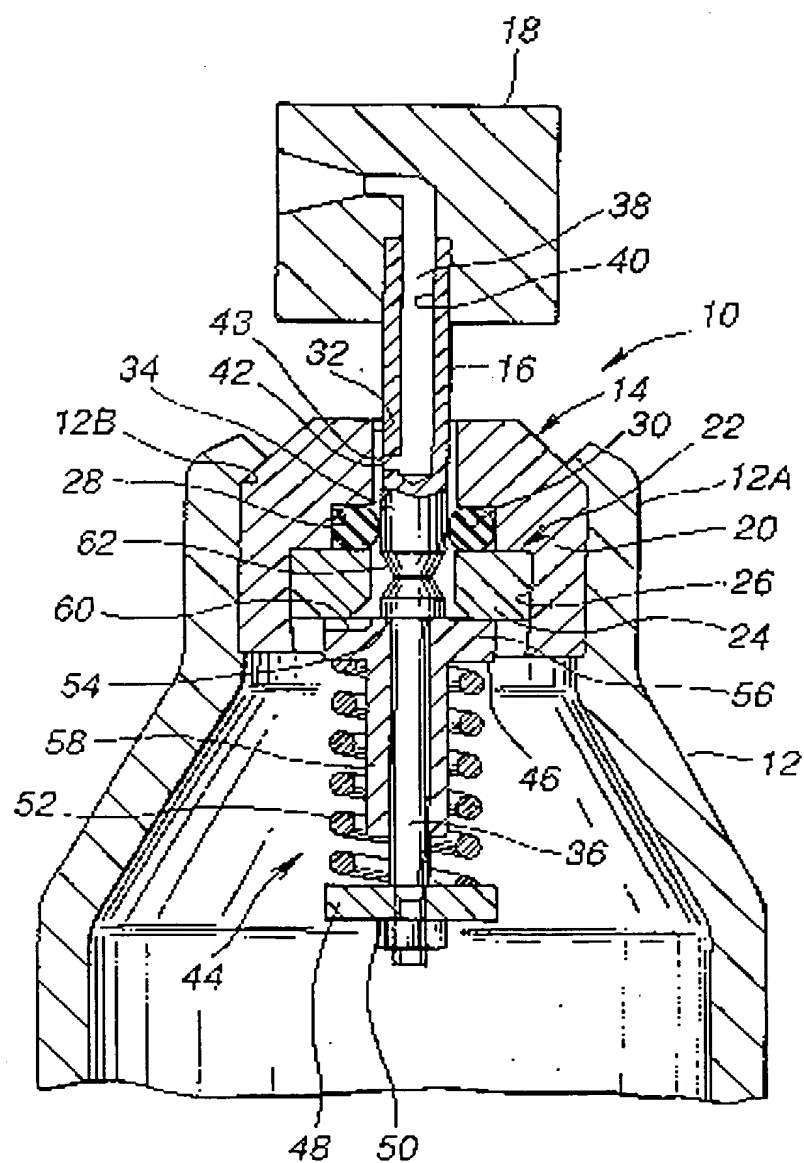
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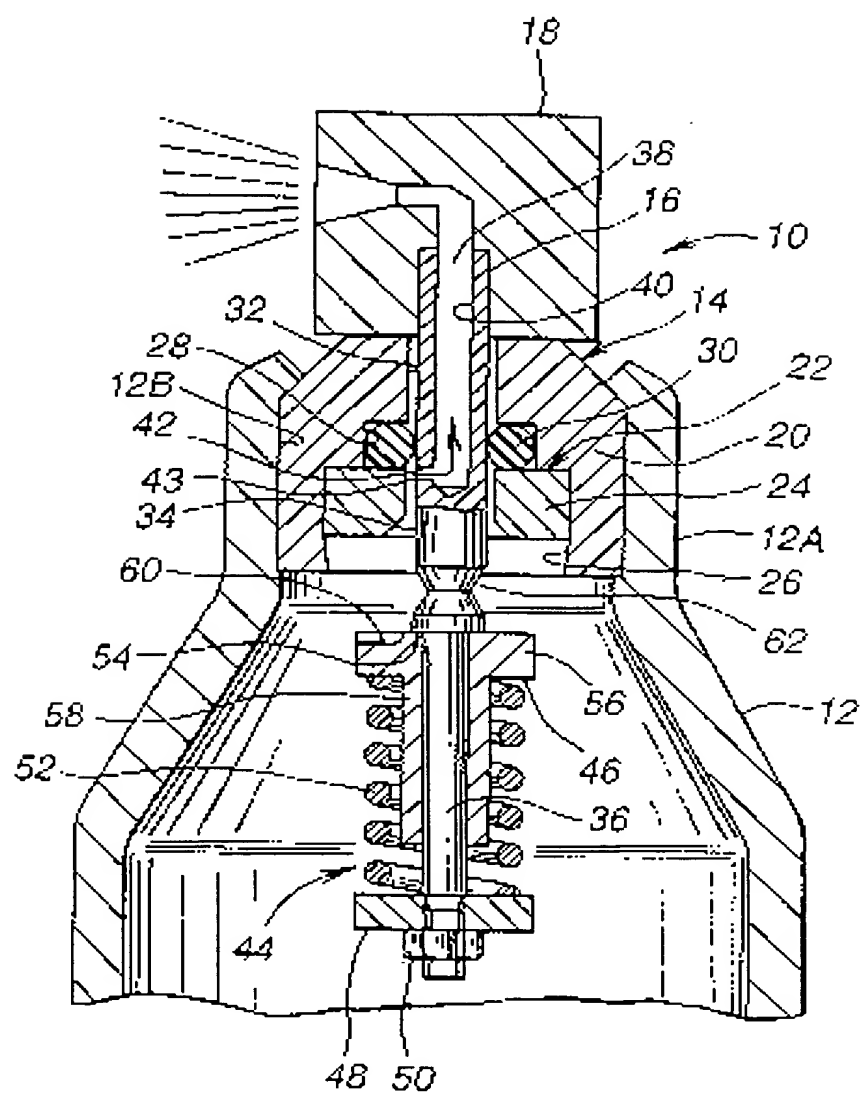
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FIG.1



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FIG.2



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FIG.3

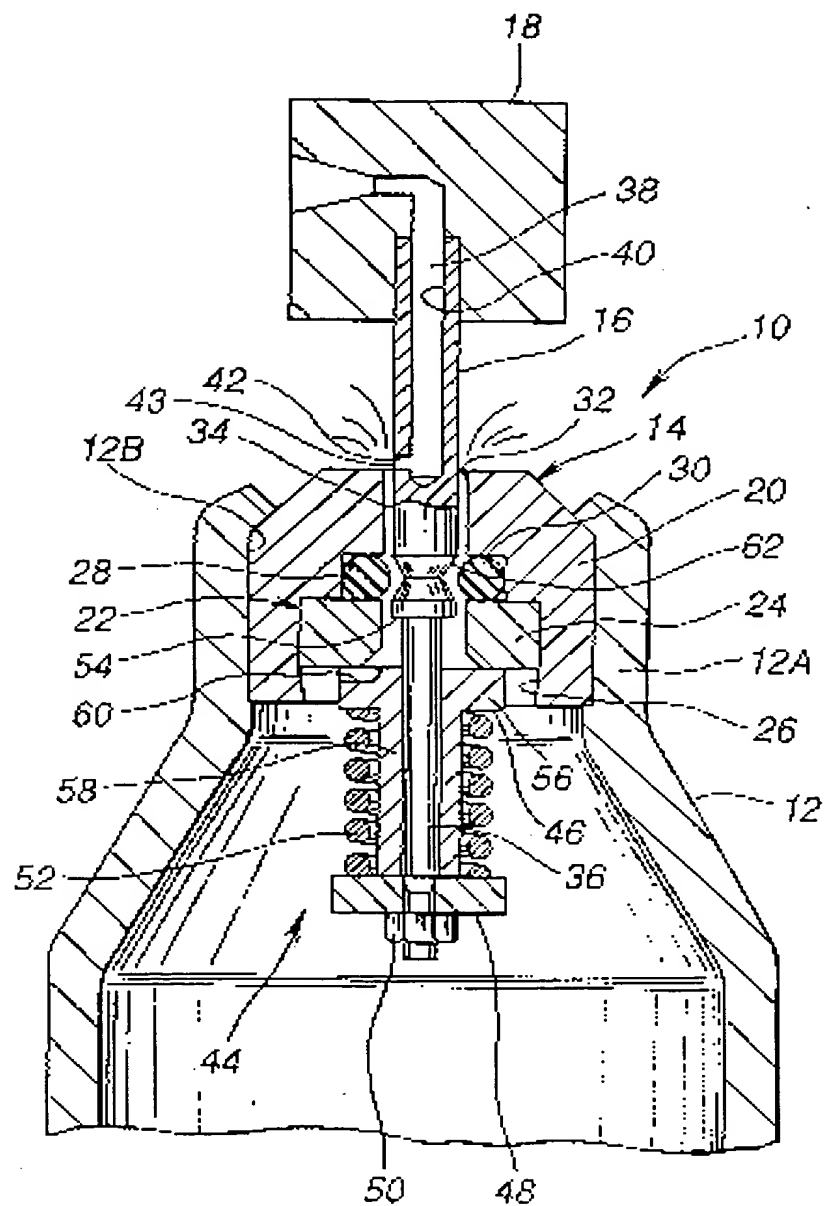


FIG.4

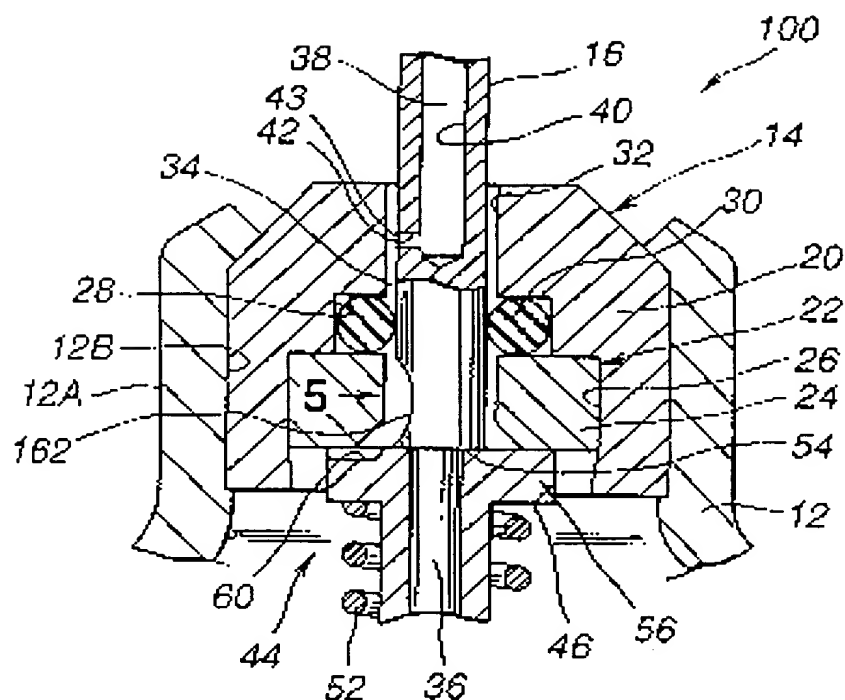
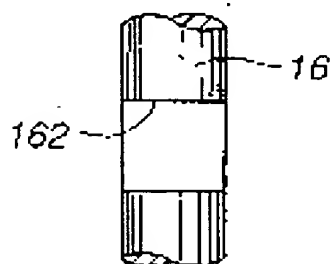


FIG.5



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FIG.6

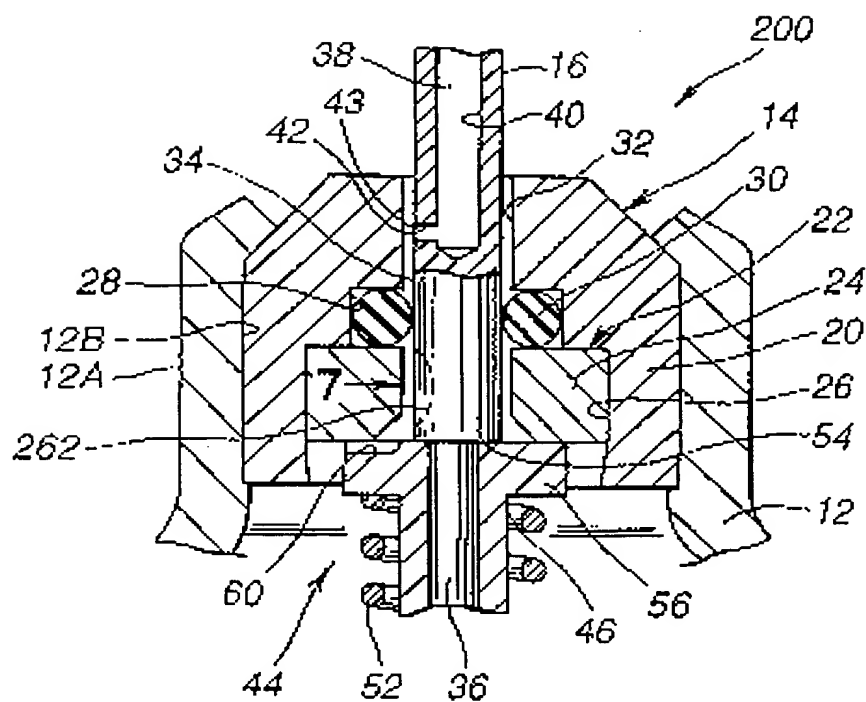


FIG.7

